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(54) **Impact energy absorptive structure**

Struktur zum Absorbieren von Stossenergie

Structure pour absorber l'énergie d'impact

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- **PATENT ABSTRACTS OF JAPAN vol. 007, no. 047 (M-196), 24 February 1983 & JP-A-57 195938 (MITSUI PORIKEMIKARU KK), 1 December 1982,**
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Description

[0001] The present invention relates in general to internally mounted impact energy absorptive structures, such as in automobiles for protecting a crew when an impact loading is given from the outside, and relates in particular to an impact absorptive internal structures having controllable impact absorptive characteristics.

[0002] Impact absorbing structures are disclosed in, for example, Japanese Utility Model Application, Second Publication, H5-410, Japanese Utility Model Application, First Publication, H3-13251, Japanese Utility Model Application, First Publication, H3-49110 and Japanese Utility Model Application, First Publication, H3-49111, which are based on styrene or urethane foams disposed at certain strategic locations within a passenger automobile.

[0003] The type of construction used in these conventional impact absorbing structures is based on encasing impact absorbing members in plastic parts. Because of such dual structures, the final cost of the impact absorbing structures is high, and their assembly steps are also increased.

[0004] An approach to remedy such a problem is disclosed in documents such as Japanese Utility Model Application, First Publication, H4-128912, and Japanese Utility Model Application, First Publication, H6-72153 which disclose a structure in which plastic rib members themselves act as impact absorbing structural members. JP-A-57,195,938 discloses an impact energy absorptive structure having a plurality of rib members for absorbing input energy.

[0005] However, the characteristics required for impact absorbing members should be different for different applications, and these publications do not disclose any specific designs for the rib structures to judge whether the impact absorbing structures can be customized to suit the conditions encountered in their applications.

[0006] It is an aim of the present invention to provide an impact energy absorptive structure whose impact resistance properties can be customized to the requirements of an application by providing a designing concept of specially shaped rib members.

[0007] Another aim of the present invention is to provide an impact energy absorptive structure having designs applicable to the application which can be manufactured by using conventional plastic materials.

[0008] FR-A-2,149,827, on which the two part form of claim 1 is based, discloses an impact energy absorptive structure having a plurality of rib members for absorbing impact energy, said ribs protruding from a base member in a direction of expected impact loading and being shaped to suit an anticipated impact load to be absorbed by said impact energy absorptive structure, wherein a thickness of said rib members increases from a tip portion of said rib members towards the base member.

[0009] According to a first aspect of the present invention there is provided an impact energy absorptive structure having a plurality of rib members for absorbing impact energy, said ribs protruding from a base member in a direction of expected impact loading and being shaped to suit an anticipated impact load to be absorbed by said impact energy absorptive structure,

wherein a thickness of said rib members increases from a tip portion of said rib members towards the base member, and

characterised in that each of the rib members is provided with a cut-out section having a width which increases in a direction from said tip portion of said rib members towards said base member.

[0010] Preferably, said cut-out section is formed in accordance with a designed pattern so that an increase in said thickness of the rib members is compensated by having said cut-out section in the direction of expected impact loading.

[0011] More preferably, said designed pattern is determined so that the rib members have a constant cross-sectional area in the direction of expected impact loading.

[0012] The width of the rib members increasing from a tip portion towards the base member facilitates removal of the manufactured structures from the mold. By choosing a proper size of the cut-out section, the impact energy to be absorbed can be adjusted to suit while maintaining the uniformity of loading on the base member itself. The capacity of the impact absorptivity can thus be adjusted to suit the application. This type of construction facilitates mold making while providing, say, constant resistance of the collapsing impact energy absorptive structures.

[0013] The material for making the impact energy absorptive structures of the present invention is preferably a thermoplastic resin. The material may be chosen from thermoplastic resins such as polyethylene, polypropylene, polyvinylchloride, nylon, polycarbonate, polyethylenetelephthalate, PMMA ABS resins and their modifiers, polymer alloy or their mixtures. Among these, polyolefin resins such as homopolymers of ethylene and/or propylene, or copolymers of them with other copolymerizable components such as alpha-olefin are preferred, and polypropylene resins are even more preferable.

[0014] Especially preferable is a thermoplastic resin composition comprising components (A) and (B) as defined next. The component (A) is an ethylene-propylene block copolymer containing 10 to 30 % by weight of an ethylene-propylene copolymer portion having ethylene content of 20 to 60 % by weight, preferably 30 to 50 % by weight. The component (B) is either an ethylene-propylene copolymer rubber or an ethylene-butenel-1 copolymer rubber. In said thermoplastic resin composition of components (A) and (B), the amount of (A) may range between 80 to 100 % by weight and the corresponding remaining amount of (B) may range between 20 to 0 % by weight. The total amount of

the component (B) and the ethylene-propylene copolymer portion in the component (A) is 15 to 40 % by weight, per 100 % by weight of the sum of the components (A) and (B). The melt index (MI) of said thermoplastic resin composition of components (A) and (B) is 5-50 g/10min., preferably 10-35 g/10min.

[0015] Such a thermoplastic resin or thermoplastic resin composition may contain fillers, such as talc, mica and glass fiber, and conventional additives, such as antioxidants, UV absorbers, anti-flammable agents and colouring agents, as needed.

[0016] The invention will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a schematic drawing of a first arrangement (PEI) of an impact energy absorptive structure which is not in accordance with the present invention but is useful for understanding;
FIG. 2 is a schematic drawings of a first comparison example (CM1) of an impact energy absorptive structure;
FIG. 3 is a schematic drawing of a second (PE2) of an impact energy absorptive structure which is not in accordance with the present invention but is useful for understanding;
FIG. 4 is a schematic drawing of a third arrangement (PE3) of an impact energy absorptive structure which is not in accordance with the present invention but is useful for understanding;
FIG. 5 is a schematic drawing of a forth arrangement (PE4) of an impact energy absorptive structure which is not in accordance with the present invention but is useful for understanding;
FIG. 6 is a schematic drawing of a fifth arrangement (PE5) of an impact energy absorptive structure which is not in accordance with the present invention but is useful for understanding;
FIG. 7 is a schematic drawing of a sixth arrangement (PE6) of the impact energy absorptive structure which is not in accordance with the present invention but is useful for understanding;
FIG. 8 is a schematic drawing of a second comparison example (CM2) of an impact energy absorptive structure;
FIG. is a schematic drawing of a first embodiment (PE7) of the impact energy absorptive structures of the present invention;
FIG. 10 is a schematic drawing of a second embodiment (PE8) of the impact energy absorptive structures of the present invention;
FIG. 11 is a graph showing the results of impact absorbing tests for the impact energy absorptive structures of the above figures ; and

[0017] The PE 1 to PE8 and CM1 to CM2 are shown in Tables 1 and 2.

[0018] Arrangements 1 to 5 were developed based on a first series of experiments. In the drawings for the following embodiments, the structure of the impact energy absorptive structures is presented schematically and the thickness of the various structures is not shown in the drawings. In all cases, impact loading is applied vertically and the top of the structures is the first point of contact with an impact load.

[0019] FIG. 1 is the structure of the impact energy absorptive structures (shortened to IAS hereinbelow) of arrangement . The IAS shown in FIG. 1 comprises the rib members having a constant width arranged in a uniform lattice pattern and protruding from a base member. The lattice pattern is designed as a 2x3 lattice configuration. That is, an IAS comprises the lattice including a base member 11, longitudinal side plates (outer rib) 12 and transverse side plates (outer rib) 13 protruding vertically from the base member 11, a middle plate (inner rib) 15 parallel to the side plates 12, and middle plates (inner rib) 14 parallel to the side plates 13. The middle plates 14, 15 are shorter than the side plates 12, 13.

[0020] The rib length (height) is denoted as L1 for the side plates 12, 13, and as L2 for the middles plates 14, 15. The rib length L1 and L2 are 60 mm and 55 mm, respectively. This design was adopted so as to absorb impact load in two-stages. The thickness of the rib members is such that the thickness of the tip portion 16 is 0.8 mm, and 1.5 mm at the base member, forming a slight taper from the base member to the tip portion. This is a limitation necessarily imposed by the need to remove the IAS from the mold used in injection molding process for manufacturing the IAS. The inter-cell spacing is 35 mm.

[0021] The material for manufacturing of the IAS was in a form of pellets comprising the ethylene-propylene block copolymer containing 28 % by weight of ethylene-propylene copolymer portion which has ethylene content of 40 % by weight. The melt index (MI) of the pellets is 15 g/10 min. The proportion of the cross sectional area of the long rib members is 0.59 of the total cross sectional area of the rib members of the IAS.

[0022] The ethylene content was determined according to the IR spectrum method described in "Polymers Handbook" pp. 256 to 257, (ii) Block Copolymers" published by Asakura Publishing, 1985.

[0023] The following Table 1 shows the results of impact strength tests carried out on the samples made in embodiments . samples (PE) 1 to 5 compared with a comparison sample (CM) 1.

[0024] Impact strength tests were conducted by using Instrumented multiaxial impact loading tester (Dart Drop Graphic Impact Tester, Model A, Toyo Seiki Co. Ltd.). The load was measured with a load cell, and the dart tip was

modified to a disk loader having 120 mm in diameter and 10 mm in thickness). The load of 6.4 Kg was dropped from a height of 1.5 m, producing an initial impact velocity of 5.4 m/s.

Table 1

Sample No.	Av. Load	Ini. Peak Value	Max. Def. Load
PE1	4400	4600	4700
CM1	4600	7400	4900
PE2	3500	4000	3500
PE3	3200	3100	3500
PE4	4200	4500	6600
PE5	4000	3100	6400

Notes: PE (preferred embodiment); CM (comparison) Av. Load (average load) Ini. Peak Value (initial peak value); Max. Def. Load (load at maximum deformation). All values in newtons.

[0025] In Table 1, the average load refers to an average of the readings taken with the load cell, and the initial peak value refers to a peak load reading during the initial impact loading stage. Load at maximum deformation refers to a load reading, which was registered by the load cell, at the time of maximum deformation.

[0026] In PE1 (FIG.1), the process of impact energy absorption begins at the tip portion 16' of the side plates 12, 13 receiving the first impact loading. In this condition, the tip portions 16 of the middle plates 14, 15 have not yet made contact with the loading surface. Therefore, only the side plates 12, 13 receive the load. The cross sectional area of said rib members 12, 13 resisting the deformation is small, and plastic deformation occurs quickly to absorb the initial peak of impact load to provide quick protection to human body.

[0027] FIG. 2 is the structures of CM1. The structures of CM1 is such that for the base member 11 there are side plates 12, 13, middle plates 14, 15 but the dimension of their lengths (heights) is uniformly 60 mm. Other dimensions of CM1 are the same as those for PE1, as are the material and manufacturing method. The result in Table 1 shows that CM1 exhibited a higher initial peak of impact load under identical testing conditions.

[0028] FIG. 3 shows the IAS of PE2. This IAS has the rib members of 0.8 mm thickness distributed uniformly in a lattice pattern, and a cut-out section (or vacant region) is provided by removing intersections lattice points formed by the middle plates 14, 15 shown in FIG. 1. The vacant region is defined by the dimensions B1 for the regions of the middle plate 14 and B2 for the regions of the middle plate 15. The structures also comprises a base member 11, side plates 12, 13, the latter two are the same as those shown in FIG. 1. The cross sectional area of the rib members are designed to absorb the energy of . the anticipated impact load. The material and the method of manufacturing of the IAS is the same as those in PE1.

[0029] An advantage of PE2 is that the thickness of the rib members and the spacing of the lattice can be adjusted to suit the anticipated impact loading. The thickness of the rib members has a certain lower limit for convenience of the manufacturing process. Impact loading is received by the base member 11, so the rib spacing or the lattice spacing cannot be made too large and certain spacing is required. By removing portions defined by B1 and B2 in the middle plates 14 and 15 to reduce the cross sectional area, it becomes possible to provide a resisting area to adjust the resisting strength of the IAS to suit the magnitude of the anticipated impact loading. By providing the vacant region, intersections of lattice points of the middle plates 14, 15 are removed and the result is a reduction in the initial peak of impact load.

[0030] The results of testing PE2, carried out under the same conditions as for PE1, shown in Table 1, indicate that the average load decreased, consistent with decreased cross sectional area of the IAS, and its initial peak of impact load also decreased.

[0031] FIG. 4 shows the IAS of PE3. This IAS has the same vacant-centers, B1 and B2 as in PE2, and the lengths (heights) L2 of the rib members 14, 15 are made shorter as in PE2. The side plates 12, 13 are the same as in PE1 and PE2.

[0032] The results of testing PE3, carried out under the same conditions as for PE1, shown in Table 1, indicate that the average load decreased, consistent with the decreased cross sectional area of the IAS, and the initial peak of impact load is equal to the average load value. The properties of the IAS of PE3 is as if a mixture of the IASs of PE1 and PE2.

[0033] FIG. 5 shows the IAS of PE4. This IAS has a latticed-configuration of side plates 12, 13 as in PE1 and has a vacant center such that the rib members of 0.8 mm in thickness at the tip portion protruding from the base member 11 are uniformly arranged. The shape of the rib members is such that the width C1 at the tip portion is narrower than the width C2 at the base member. The material and the manufacturing method are the same as in PE1.

[0034] The cross sectional area of the rib members is designed so as to absorb impact loading gradually increased.

The shape is suitable to increasing resistance of the rib members as the deformation progresses, which represents a desirable impact absorbing behaviour of the IAS. The vacant-regions B1, B2 of the middle plates 14, 15 and the changing dimensions from C1 to C2 combine to produce a desirable impact absorbing behavior. The results of testing PE4, under the same conditions as in other samples, reported in Table 1, demonstrate that the initial peak of impact load is reduced while offering high energy absorption.

[0035] FIG. 6 shows the IAS of PE5. This IAS has a latticed-configuration of side plates 12, 13 as in PE1 and has a vacant center such that the rib members of 0.8 mm in thickness at the tip portion protruding from the base member 11 are uniformly arranged. The shape of the rib members is such that the width C1 at the tip portion is narrower than the width C2 at the base member. The rib lengths (heights) L2 of the middle plates 14, 15 is made short as in PE1. The material and the manufacturing method are the same as in PE1.

[0036] The cross sectional area of the rib members is designed to offer increasing resistance to deformation as the impact loading is applied and the structures collapse. By providing the vacant regions B1, B2 and making the middle rib members 14, 15 short, initial peak of impact load is reduced. By increasing the rib width gradually from C1 to C2 and thereby increasing the cross sectional area, a desirable pattern of impact resistance can be obtained.

[0037] Table 1 presents the results of testing PE5 under the same conditions of testing for all others.

[0038] Next, a second series of testing IASs having a second basic configuration shown in FIGS. 7 to 8 will be explained with specific reference to PE6, PE7 and PE8. The difference between the first and second series IASs is that in the second series IASs have a rib length (height) of 80 mm, the thickness of tip portion of 0.6 mm and a lattice configuration of 2x2. The facts that the thickness of the tip portion of the rib members is smaller than that at the base member, that an expanding tapered shape of the rib members is towards the base member, other dimensions, material and the manufacturing methods are the same as in the first series. As previously indicated PE6 which is not in accordance with the present invention but is useful for understanding, but PE7 and PE87 are in accordance with the present invention. FIG.7 shows a structure of the ISA of PE6. The IAS of PE6 has side plates (outer rib) 12A of length (height) L1, middle plates (inner ribs) 14A of length (height) L2 where L1>L2. The proportion of the cross sectional area of the long rib members is 0.3 of the total cross sectional area of the rib members which corresponds to PE1 in the first series, and the effects of the rib members in offering resistance to deformation are the same as PE1.

[0039] Table 2 shows the results of impact testing of IASs of second series. The testing apparatus was basically the same as that used in testing the first series, but the impact loading was higher. The load of 20.0 Kg was dropped from a height of 1.0 m, producing an initial impact velocity of. 4.5 m/s. This series is made to be applicable where the impact energy overall is higher than that in the first series, and the corresponding maximum deformation was 40 mm compared with 20 mm in the first series.

Table 2

Sample No.	Av. Load	Ini. Peak Value	Max. Def. Load
PE6	2300	2400	3500
CM2	2600	4300	3500
PE7	1600	1500	1700
PE8	1700	1600	2000

Notes: PE (preferred embodiment); CM (comparison) Av. Load (average load) Ini. Peak Value (initial peak value); Max. Def. Load (load at maximum deformation). All values in newtons.

[0040] FIG. 8 shows the results obtained by CM2 tested under the same conditions as those for PE6, and the comparison is equivalent to CM1 in the first series. In this IAS, the height L1 of all the rib members (side plates 12A and middle plates 14A) is 80 mm. The test results in Table 2 show that CM2, as well as CM1, exhibited a higher initial peak of impact load than the average load. In contrast, the peak of impact load in PE6 is held down low while the value of the load at maximum deformation for both PE6 and CM1 were the same.

[0041] FIG. 9 shows the ISA of PE7 which is an embodiment of the present invention. The basic structure of PE7 is the same as that of PE6, thus the thickness of the rib members decreases gradually from the base member 11 towards the tip portion 16. A feature which has been added to PE7 is that a cut-out section (vacant space) 17 has been added such that the width of the cut-out section 17 increases gradually from the tip portion 16 to the base member 11 as seen in FIG. 9. The dimensions of the cut-out section 17 is determined so that an increase in the cross sectional area caused by the increasing thicknesses of the rib members 12A, 14A is compensated by having the cut-out section 17, thus maintaining approximately a constant cross sectional area of the rib members in the direction of impact loading.

[0042] The above-noted structure of PE7 presents an advantage that the load does not increase during the deformation process of the rib members caused by an impact loading. This is thought to be the result of approximately constant cross sectional area presented along the direction of impact loading, and therefore the load required for

collapsing of the rib members does not increase noticeably.

[0043] The results of testing PE7 under the same test conditions as PE6 and CM2 are presented in Table 2. For PE7, the average load is lower which is consistent with the decrease in the cross sectional area, and the initial peak of impact load is further reduced in comparison to PE6. The load at maximum deformation for PE7 is lowered further in comparison with PE6 and CM2. This is because the cross sectional area of the regions close to the base member 11 does not increase as the deformation process is continued, consequently the collapsing strength is maintained constant throughout the impact loading process.

[0044] FIG. 10 shows the ISA of PE8 which is an embodiment of the present invention. Similar, to the design of PE7, this structure is also provided with a cut-out section 18 on rib members 12A so that the width of the cut-out section 18 increases towards the base member 11 to control the variation of the cross sectional area in the deformation process. The cut-out 18 is not provided on the interior rib members but only on the rib members 12A which constitute the wall section of the IAS of PE8. This is a choice made so as to facilitate manufacturing, by inserting a core of a shape to correspond with the shape of the cut-out 18 into an injection mold.

[0045] The cut-out 18 provided only on the outer walls performs an equivalent function as the cut-out 17 which is provided on all of the rib members, therefore, the size of cut-out 18 is made to be comparatively large.

[0046] The results of testing PE8 under the same test conditions as PE6 are reported in Table 2. For PE8, the average load is lower which is consistent with the decrease in the cross sectional area, and the initial peak of impact load is between that of PE6 and PE7. It is thus noted that the performance of PE8 is somewhere between those of PE6 and PE7.

[0047] FIG. 11 is a graph which summarizes the results of impact testing of PE1 to PE8. Here, the average cross sectional area of the rib members ($\overline{S(x)}$) is an average of the cross sectional area (S(x)) of the rib members as a function of the displacement (x) along the direction orthogonal to the base member. The average load ($\overline{F(x)}$) is an average value of the load (F(x)) detected by the load cell as a function of the displacement (x). According to this graph, it can be seen that the correspondence between $\overline{S(x)}$ and $\overline{F(x)}$ during impact testing is excellent. Therefore, by using these results, it is possible to calculate an average cross sectional area to correspond to a certain impact load, and to present suitable impact resisting structures to suit an application. Further, the rib members collapse with time, therefore, the displacement (x) is also a function of time. Therefore, the cross sectional area under load and the load change with time (t). FIG. 11 shows that cross sectional area (S(t)) and the load (F(t)) also exhibit a correlation. In other words, by controlling the time-dependent cross sectional area of the rib members which collapse under load, it is possible to obtain a pattern for the time-dependent impact resistance strength (F(t)).

[0048] For instance, an example of the impact energy absorptive structures is a requirement for a constant impact resistance pattern for F(t), in which case, it is possible to design the rib members so that S(t) becomes constant over the time period of application of an impact loading.

[0049] The conceptual framework has thus been demonstrated that an impact loading can be absorbed in a multi-stage collapsing mode in which the impact energy absorbed by the rib member can be varied during the collapsing of the impact energy absorptive structures so as to present a customized absorption to suit an application. The concept was illustrated with reference to specific examples, but other designs and combinations are obviously possible. For example, the concept illustrated in FIGS. 3 to 6 can be applied to combinations represented by embodiments shown in FIGS. 7, 9 and 10 to generate a suitable IAS of optimum performance.

[0050] Further, the above embodiments were based on uniformly spaced rib members of square shape in a lattice configuration. However, the rib members need not be restricted to square shaped lattice configuration, and other shapes such as a triangle or a hexagonal shape can be utilized equally effectively.

[0051] It should be obvious that the numerical values for the sizes and the shapes pertaining to these IASs should be chosen in association with their structure, end use and manufacturing methods. The method of manufacturing need not be limited to injection molding, and compression molding may be used equally effectively.

[0052] In all the preceding structures the rib members protrude from a flat base member and the contact region on the rib members is also flat, but it is obvious that both the base member and the contact region can assume curved shapes to suit end use applications.

Claims

1. An impact energy absorptive structure having a plurality of rib members (12A, 14A) for absorbing impact energy, said ribs protruding from a base member (11) in a direction of expected impact loading and being shaped to suit an anticipated impact load to be absorbed by said impact energy absorptive structure,

   wherein a thickness of said rib members (12A, 14A) increases from a tip portion of said rib members towards the base member (11), and

   characterised in that each of the rib members is provided with a cut-out section (17, 18) having a width which increases in a direction from said tip portion of said rib members (12A, 14A) towards said base member (11).

2. A structure according to claim 1, wherein said cut-out section (17, 18) is formed in accordance with a designed pattern so that an increase in said thickness of the rib members (12A, 14A) is compensated by having said cut-out section (17, 18) in the direction of expected impact loading.

3. A structure according to claim 2, wherein said designed pattern is determined so that the rib members (12A, 14A) have a constant cross-sectional area in the direction of expected impact loading.

4. A structure according to any one of the preceding claims, wherein the material of the impact energy absorptive structure is a thermoplastic resin.

5. A structure according to claim 4, wherein the material is chosen from the group consisting of thermoplastic resins such as polyethylene, polypropylene, polyvinylchloride, nylon, polycarbonate, polyethylenetelephthalate, PMMA ABS resins and their modifiers, polymer alloy or their mixtures.

6. A structure according to claim 5, wherein the material is a homopolymer of ethylene and/or propylene, or a copolymer of ethylene and propylene with other copolymerizable components.

7. A structure according to any one of claims 4 to 6, wherein the thermoplastic resin contains fillers and/or additives.

8. A structure according to any one of claims 1 to 3, wherein the material of the impact energy absorptive structure is a thermoplastic resin composition comprising components (A) and (B) where

component (A) is an ethylene-propylene block copolymer containing 10 to 30% by weight of an ethylene-propylene copolymer portion having ethylene content of 20 to 60 % by weight, and

component (B) is either an ethylene-propylene copolymer rubber or an ethylene butenel-1 copolymer rubber.

9. A structure according to claim 8, wherein the melt index of said thermoplastic resin composition of components (A) and (B) is 5 to 50 g/10min.

10. A structure according to claim 8 or 9, wherein, in the thermoplastic resin composition, the amount of component (A) is between 80 to 100 % by weight and the amount of component (B) is the remaining amount.

11. A structure according to claim 10, wherein the total amount of component (B) and the ethylene-propylene copolymer portion in component (A) is 15 to 40 % by weight, per 100 % by weight of the sum of the components (A) and (B).

12. A structure according to any one of claims 8 to 11, wherein the thermoplastic resin composition contains fillers and/or additives.

Patentansprüche

1. Struktur zum Absorbieren von Stoßenergie mit mehreren Rippenelementen (12A, 14A) zum Absorbieren von Stoßenergie, wobei diese Rippen von einem Sockelelement (11) in eine Richtung der erwarteten Stoßbelastung vorstehen und derart geformt sind, daß sie für eine erwartete Stoßbelastung, die von der Struktur zum Absorbieren von Stoßenergie absorbiert werden soll, geeignet sind,

wobei die Dicke der Rippenelemente (12A, 14A) von einem Spitzenteil der Rippenelemente in Richtung des Sockelelements (11) zunimmt, und

dadurch gekennzeichnet, daß jedes der Rippenelemente mit einem Ausschnittabschnitt (17, 18) versehen ist, der eine Breite hat, die in einer Richtung von dem Spitzenteil der Rippenelemente (12A, 14A) zum Sockelteil (11) hin zunimmt.

2. Struktur nach Anspruch 1, wobei der Ausschnittabschnitt (17, 18) gemäß einem konstruierten Muster gebildet wird, so daß eine Zunahme der Dicke der Rippenelemente (12A, 14A) dadurch ausgeglichen wird, daß der Ausschnittabschnitt (17, 18) in der Richtung der erwarteten Stoßbelastung vorhandenen ist.

3. Struktur nach Anspruch 2, wobei das konstruierte Muster derart bestimmt wird, daß die Rippenelemente (12A, 14A) in der Richtung der erwarteten Stoßbelastung eine konstante Querschnittfläche haben.

4. Struktur nach einem der vorangehenden Ansprüche,

wobei das Material der Struktur zum Absorbieren von Stoßenergie ein thermoplastisches Kunstharz ist.

5. Struktur nach Anspruch 4, wobei das Material aus der Gruppe ausgewählt wird, die aus thermoplastischen Kunstharzen, wie etwa Polyethylen, Polypropylen, Polyvinylchlorid, Nylon, Polykarbonat, Polyethylenterephthalat, PMMA/ABS-Harzen und ihren Modifikationsmitteln, Polymerlegierungen oder ihren Mischungen besteht.

6. Struktur nach Anspruch 5, wobei das Material ein Homopolymer von Ethylen und/oder Propylen oder ein Copolymer von Ethylen und Propylen mit anderen Copolymerisierbaren Bestandteilen ist.

7. Struktur nach einem der Ansprüche 4 bis 6, wobei das thermoplastische Kunstharz Füllstoffe und/oder Zusatzstoffe enthält.

8. Struktur nach einem der Ansprüche 1 bis 3, wobei das Material der Struktur zum Absorbieren von Stoßenergie eine thermoplastische Kunstharzzusammensetzung ist, die Bestandteile (A) und (B) aufweist, wobei
der Bestandteil (A) ein Ethylen-Propylen-Blockcopolymer ist, das 10 bis 30 Gewichtsprozent eines Ethylen-Propylen-Copolymeranteils mit einem Ethylengehalt von 20 bis 60 Gewichtsprozent enthält, und
der Bestandteil (B) entweder ein Ethylen-Propylen-Copolymerkautschuk oder ein Ethylen-Buten-1-Copolymerkautschuk ist.

9. Struktur nach Anspruch 8, wobei der Schmelzindex der thermoplastischen Kunstharzzusammensetzung aus Bestandteilen (A) und (B) 50 g/10 min beträgt.

10. Struktur nach Anspruch 8 oder 9, wobei die Menge des Bestandteils (A) in der thermoplastischen Kunstharzzusammensetzung zwischen 80 und 100 Gewichtsprozent ist und die Menge des Bestandteils (B) die restliche Menge ist.

11. Struktur nach Anspruch 10, wobei die Gesamtmenge des Bestandteils (B) und des Ethylen-Propylen-Copolymeranteils in dem Bestandteil (A) 15 bis 40 Gewichtsprozent pro 100 Gewichtsprozent der Summe der Bestandteile (A) und (B) ist.

12. Struktur nach einem der Ansprüche 8 bis 11, wobei die thermoplastische Kunstharzzusammensetzung Füllstoffe und/oder Zusatzstoffe enthält.

Revendications

1. Structure d'absorption d'énergie d'impact ayant une pluralité de nervures (12A,14A) pour absorber l'énergie d'impact, lesdites nervures dépassant à partir d'une base (11) en direction de la charge d'impact attendue et ayant une forme adaptée à une charge d'impact anticipée à absorber par ladite structure d'absorption d'énergie d'impact,
dans laquelle une épaisseur desdites nervures (12A,14A) augmente à partir d'une partie en pointe desdites nervures en direction de la base (11), et
caractérisée en ce que chacune des nervures est munie d'une partie découpée (17,18) ayant une largeur qui augmente dans une direction à partir de ladite partie en pointe desdites nervures (12A,14A) vers ladite base (11).

2. Structure selon la revendication 1, dans laquelle ladite section découpée (17,18) est formée selon une configuration conçue de telle sorte qu'une augmentation de ladite épaisseur desdites nervures (12A,14A) est compensée en ayant la partie découpée (17,18) dans la direction de la charge d'impact attendue.

3. Structure selon la revendication 2, dans laquelle ladite configuration est déterminée de telle sorte que les nervures (12A,14A) ont une section transversale constante dans la direction de la charge d'impact attendue.

4. Structure selon l'une des revendications précédentes, dans laquelle le matériau de la structure d'absorption d'énergie d'impact est une résine thermoplastique.

5. Structure selon la revendication 4, dans laquelle le matériau est choisi dans le groupe composé des résines thermoplastiques comme le polyéthylène, le polypropylène, le polychlorure de vinyle, le nylon, le polycarbonate, le téréphtalate de polyéthylène, les résines PMMA ABS et leurs adjuvants, leur alliages de polymères et leurs mé-

langes.

6. Structure selon la revendication 5, dans laquelle le matériau est un homopolymère d'éthylène et/ou de propylène ou un copolymère d'éthylène et de propylène avec d'autres composants copolymérisables.

7. Structure selon l'une des revendications 4 à 6, dans laquelle la résine thermoplastique contient des charges et/ou des adjuvants.

8. Structure selon l'une des revendications 1 à 3, dans laquelle le matériau de la structure d'absorption d'énergie d'impact est une composition de résine thermoplastique comprenant les composants (A) et (B), où :

le composant (A) est un copolymère séquencé éthylène-polypropylène contenant 10 à 30% en poids de copolymère éthylène-propylène ayant une teneur en éthylène de 20 à 60% en poids, et
le composant (B) est soit un caoutchouc à copolymère éthylène-propylène soit un caoutchouc à copolymère éthylène-buténe 1.

9. Structure selon la revendication 8, dans laquelle l'indice de fluidité desdits composants (A) et (B) dudit mélange de résines thermoplastiques est de 5 à 50 g/10 min.

10. Structure selon la revendication 8 ou 9, dans laquelle, dans le mélange de résines thermoplastiques, la quantité du composant (A) est entre 80 et 100% en poids et la quantité du composant (B) est la quantité restante.

11. Structure selon la revendication 10, dans laquelle la quantité totale de composant (B) et la partie de copolymère éthylène-propylène dans le composant (A) est de 15 à 40% en poids, pour 100% en poids de la somme des composants (A) et (B).

12. Structure selon l'une des revendications 8 à 11, dans laquelle le mélange de résines thermoplastiques contient des charges et/ou des adjuvants.

FIG. 1

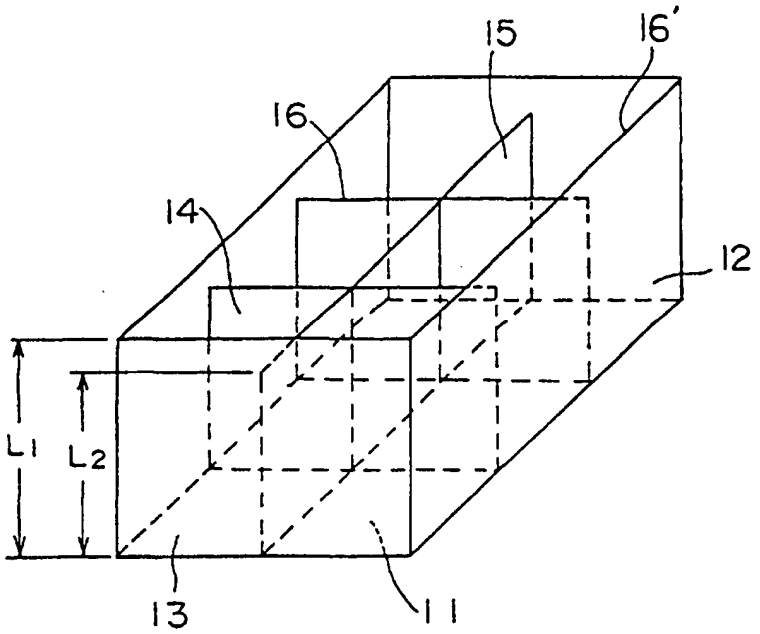


FIG. 2

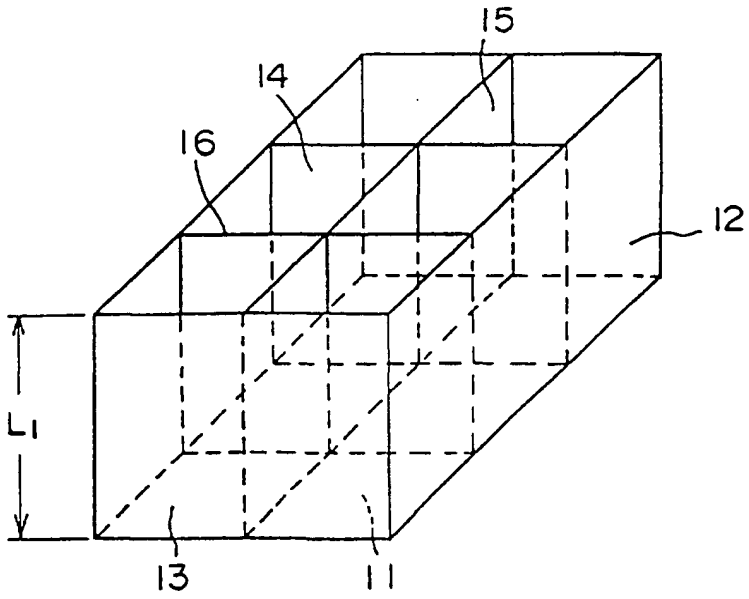


FIG. 3

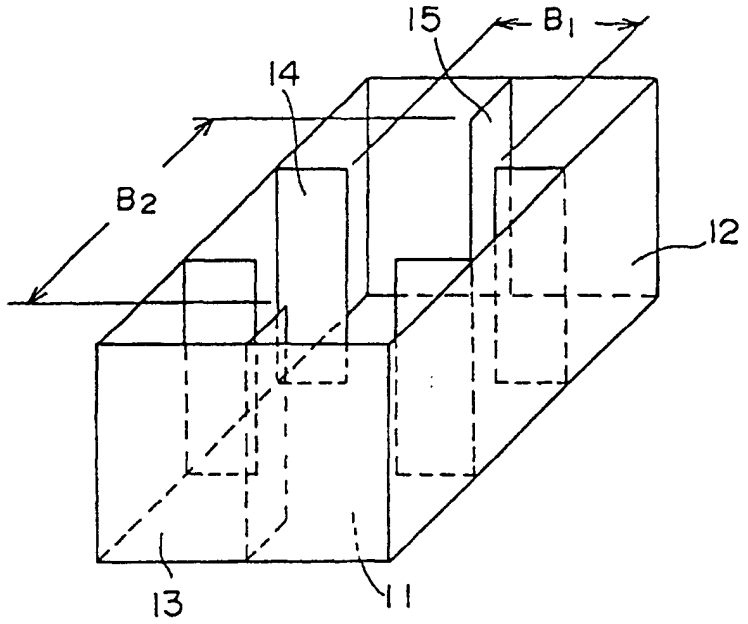


FIG. 4

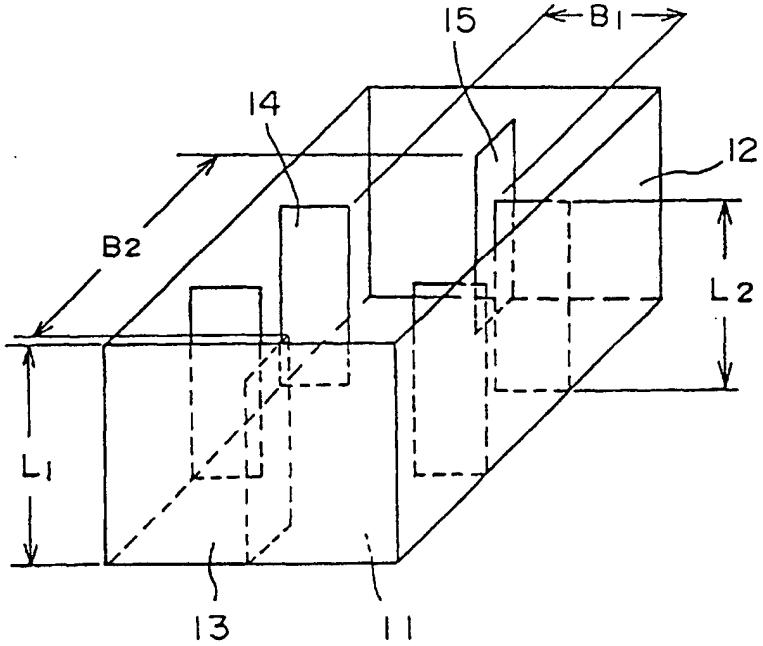


FIG. 5

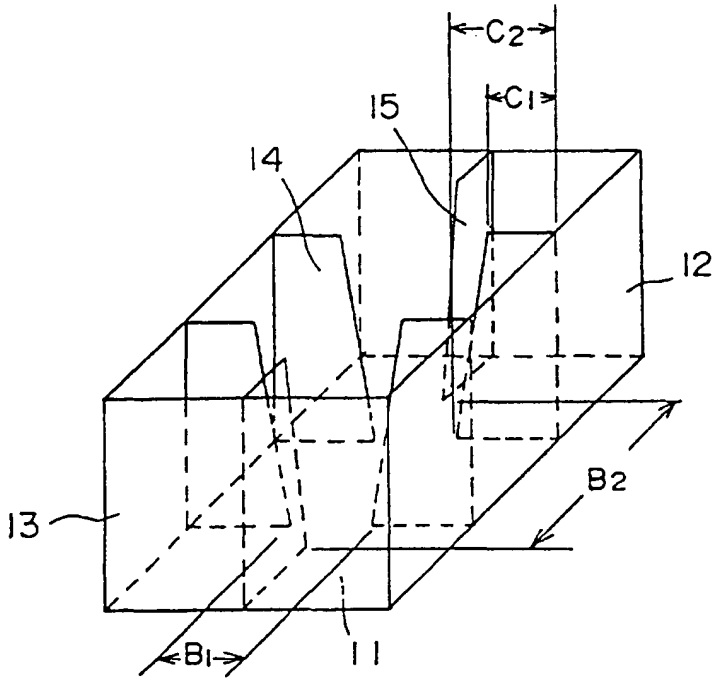


FIG. 6

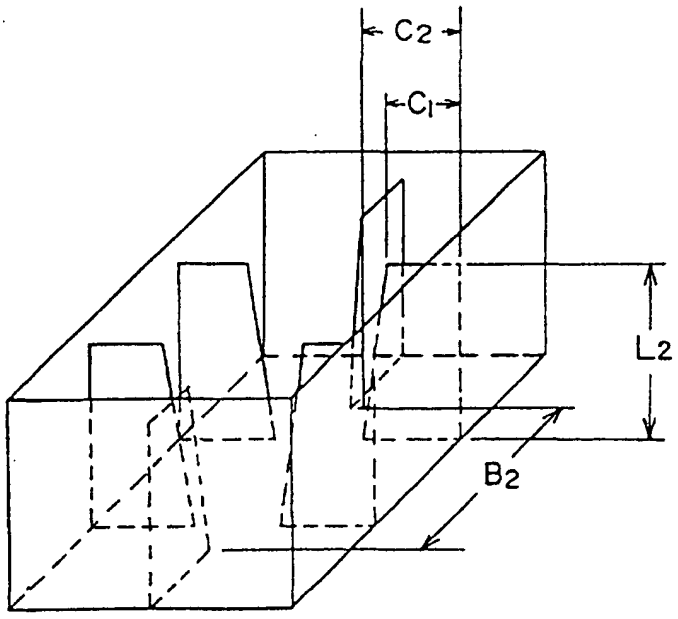


FIG. 7

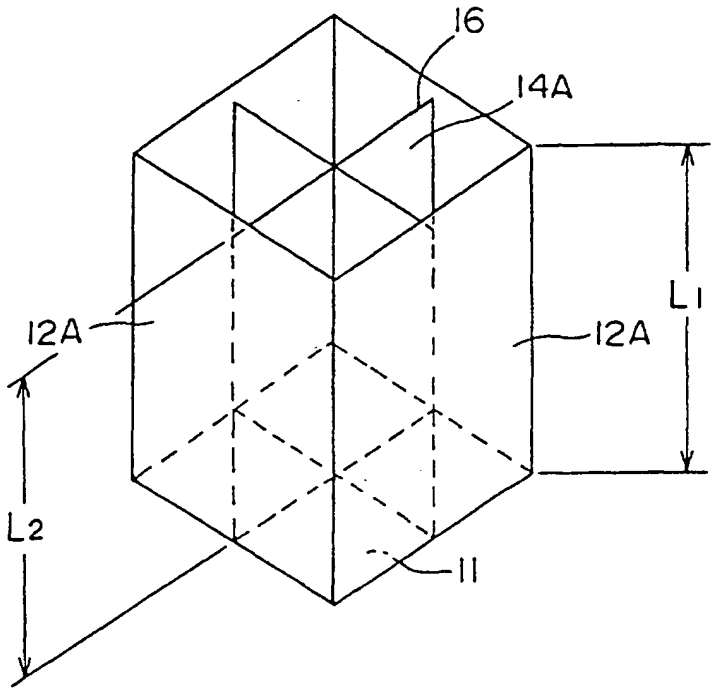


FIG. 8

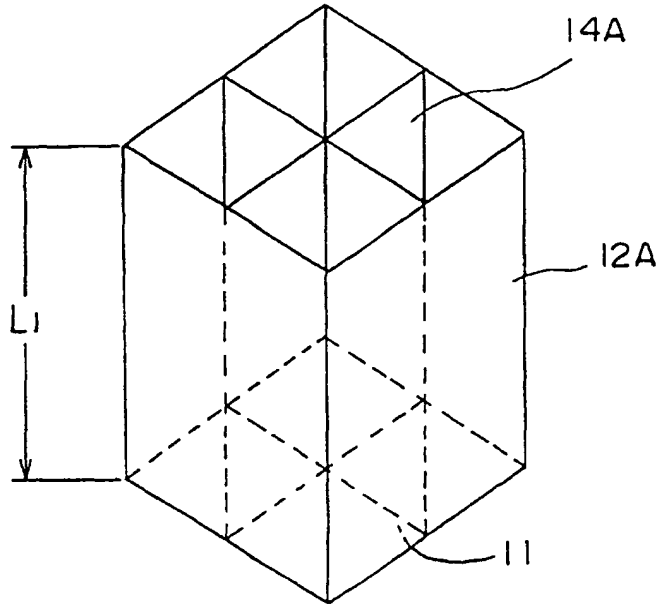


FIG. 9

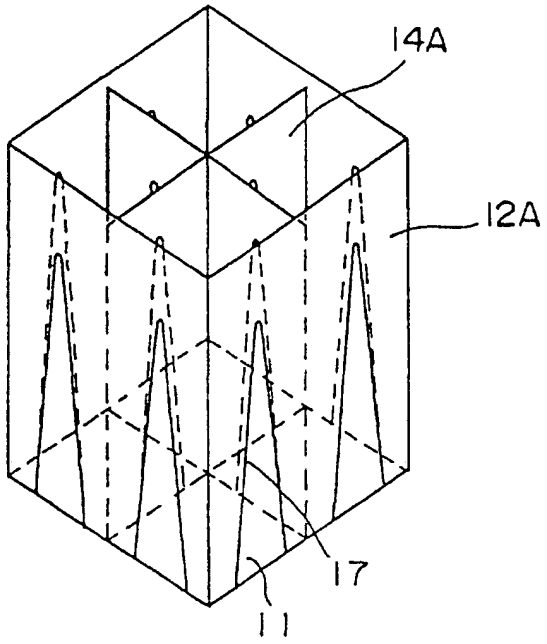


FIG. 10

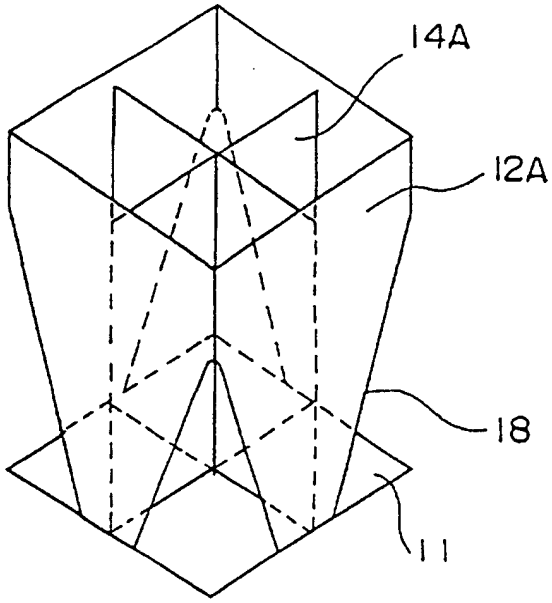
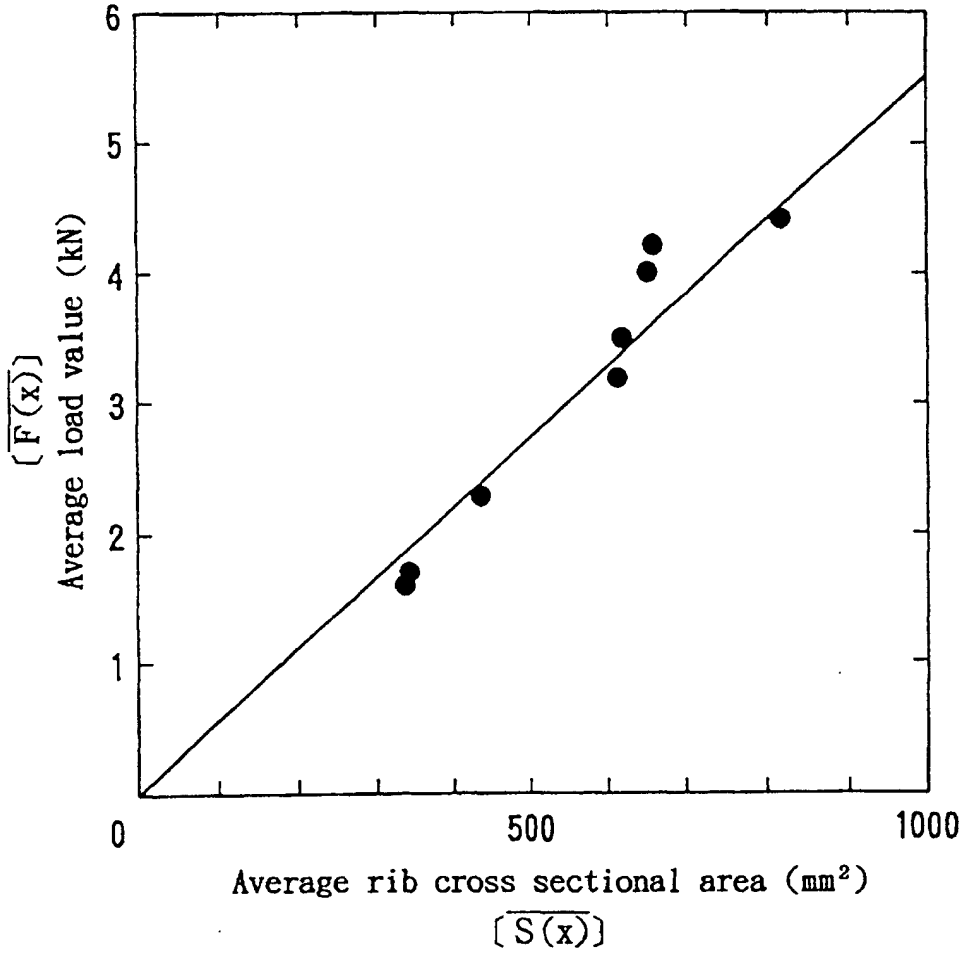


FIG. 11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5
4
3
2
1
0
500
1000
Average load value (kN)
〔F(x)〕
Average rib cross sectional area (mm²)
〔S(x)〕